Aircraft Surveillance Applications (Extracts from ASA MASPS, DO-289)

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April, 2004

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Introduction

- Overview of ASA MASPS
  - Relationship between RTCA standards documents
- ASA MASPS System and Functional Architectures
- Requirements Overview
  - Safety and Nominal Performance
  - Transmit Quality Levels (TQL) and ASA Capability Level (ACL)
- Analysis Methodology using ASIA application example
  - Phase and Process Diagram
  - Safety Table: Identification of operational hazards and operational consequences
  - Fault tree analysis for assessment of target level of safety

Overview of ASA MASPS - RTCA DO-289

- **ASA MASPS**
  - **Aircraft Surveillance Applications (ASA) Minimum Aviation System Performance Standards (MASPS)**
- **Provides system and sub-system performance requirements that to support ASA applications**
  - **Intended to provide framework for current and future applications**
- **ASA applications considered in MASPS**
  - **Detailed analyses**
    - Enhanced Visual Acquisition (EVAcq)
    - Enhanced Visual Approach (EVApp)
    - Airport Surface Situational Awareness (ASSA)
    - Final Approach and Runway Occupancy Awareness (FARAO)
    - Conflict Detection (CD)
  - **'Probing' analyses (evaluation of future requirements)**
    - Approach Spacing for Instrument Approaches (ASIA)
    - Independent Closely Parallel Approaches (ICSPA)
    - Airborne Conflict Management (ACM)

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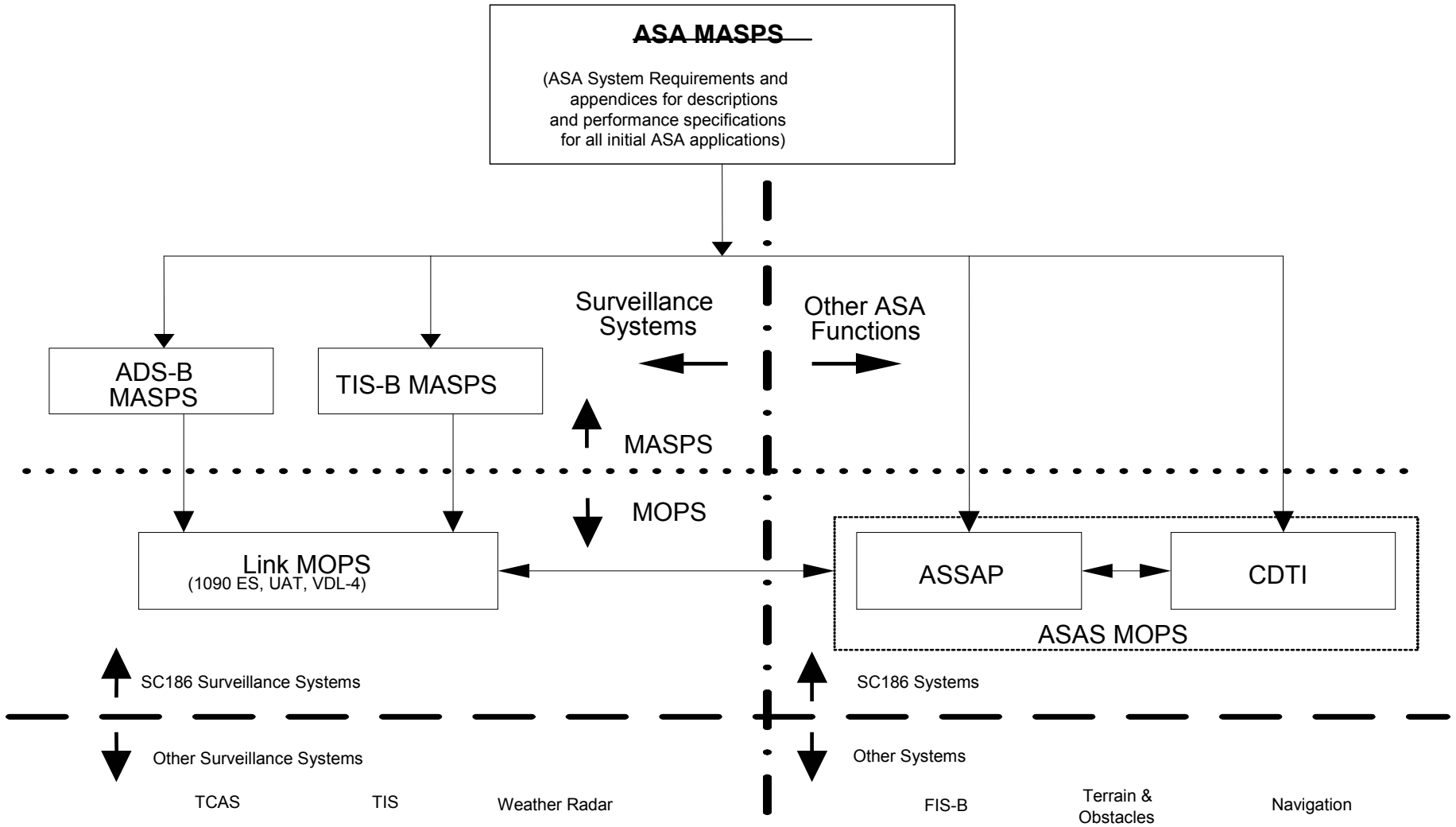
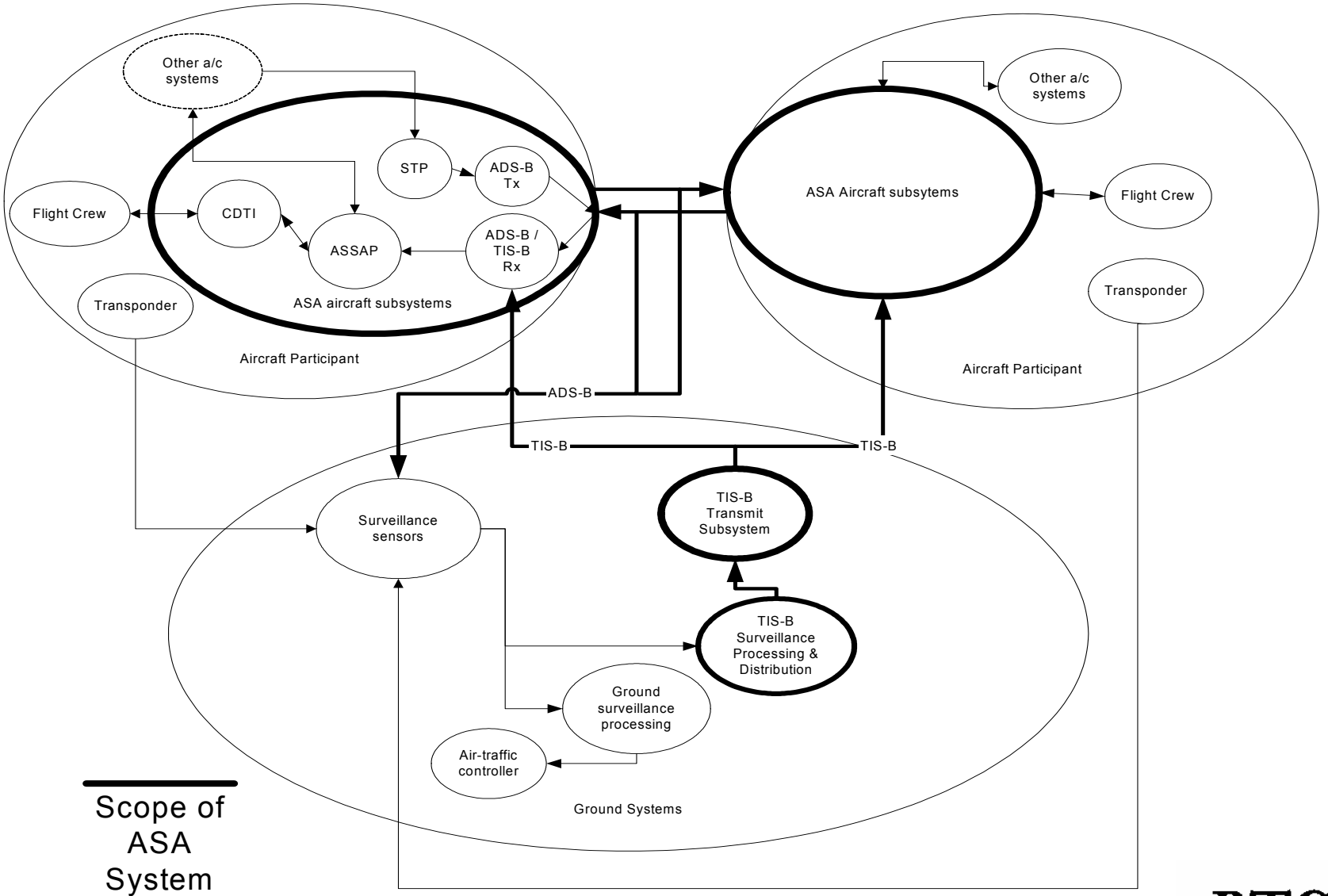
Relationship between ASA MASPS and other RTCA Documents



Surveillance and Separation Assurance System Architecture



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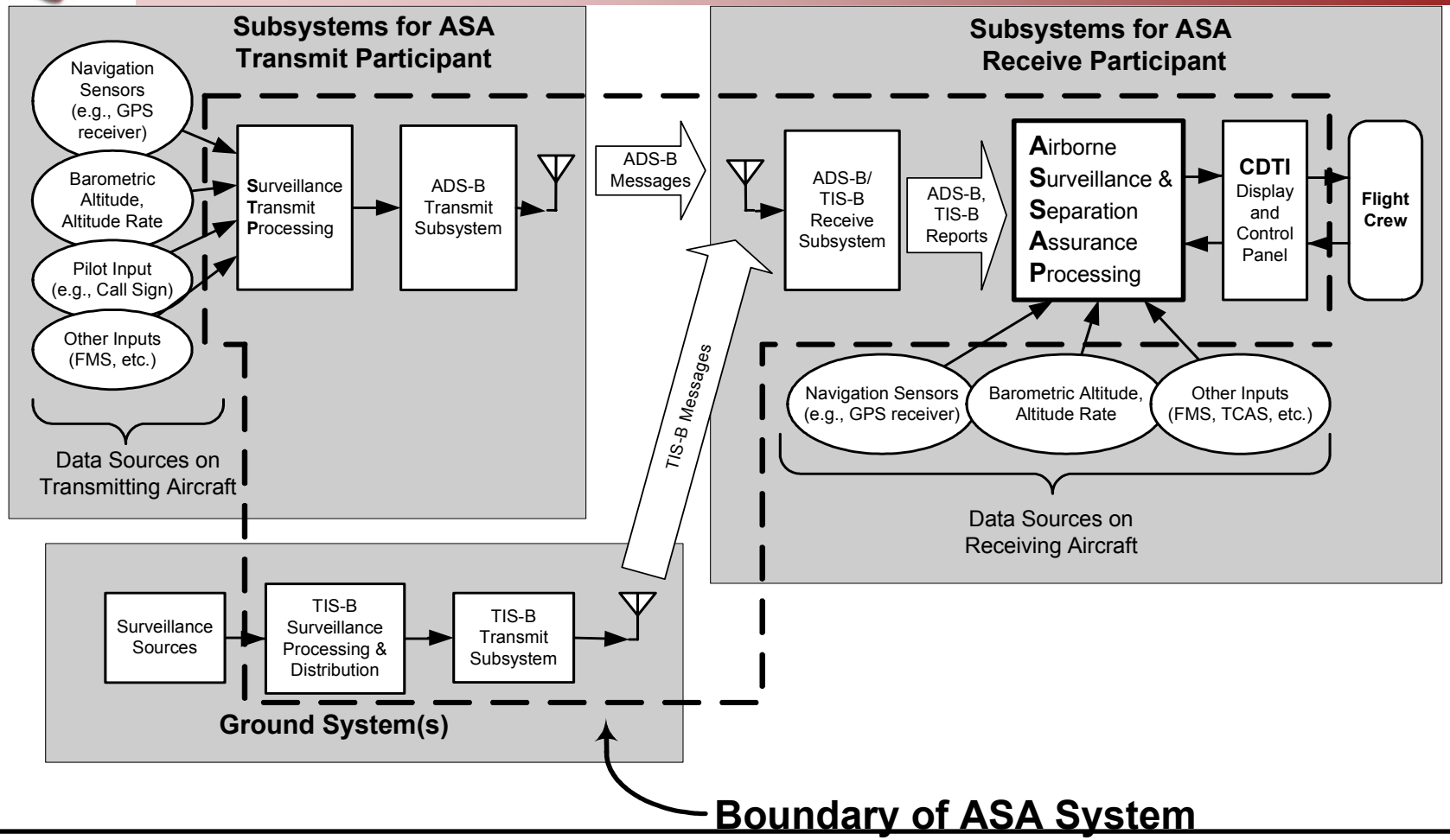
Overview of ASA Architecture



ASA MASPS represents a 'system-of-systems' with multiple interfaces; extends beyond conventional, standalone avionics systems

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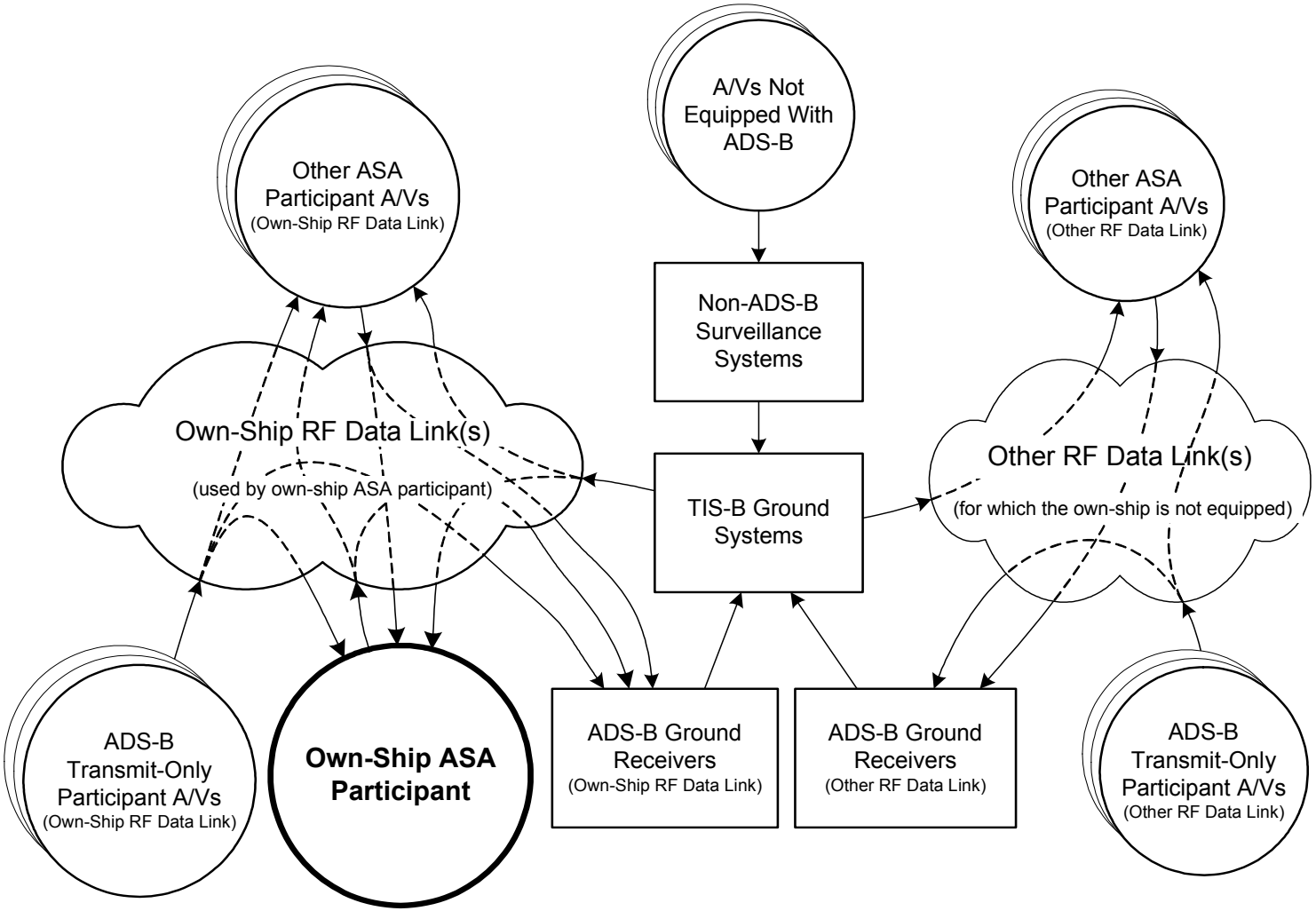
ASA System Participants Context Diagram



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Requirements Overview

- **Safety Requirements**
  - **Assessment of operational consequences, operational hazards, target level of safety**
    - Follows modified RTCA DO-264/ EUROCAE ED78A analysis methodology
    - Results in system and subsystem integrity allocations
- **Nominal Performance Requirements**
  - **Parameters analyzed**
    - Data latency, Navigation Accuracy Category for position and velocity (NACp, NACv), Navigation Integrity Containment (NIC), Surveillance Integrity Level (SIL), maximum time to indicated integrity change, update period, maximum age of applicability of surveillance data, continuity of service, availability, etc.
  - **Nominal performance analyses utilized variety of techniques, including static analysis and Monte Carlo simulation to determine requirements sensitivities**

Requirements Categorization (TQL, ACL)

- **Requirements were classified into categories / groups**
  - **Transmit Quality Level (TQL)**
  - **ASA Capability Level (ACL)**

- **Rationale for grouping of requirements**
  - **Reduced number of equipment configurations**
  - **Simplified certification due to reduced equipment configurations, thus reducing a proliferation of system and sub-system dependencies**
  - **Simplified documentation of requirements**
  - **Communication of application capabilities and data quality to ATC and end users**

Transmit Quality Level (TQL)

- **Broadcast parameter that provides data quality indication**
  - **Broadcast by on-board ADS-B transmit subsystem or a TIS-B ground station**
  - **Indicates quality of transmitted surveillance information in addition to NIC, NAC, SIL, etc. that allows users to assess the suitability of received surveillance information to support a user application**
  - **TQLs are hierarchical, i.e., higher TQLs announce that a participant supports the capabilities of all lower TQLs**
  - **Four levels of TQL are defined (Refer to Table 3-1 in ASA MASPS)**
  - **TQL data characteristics**
    - Maximum ASA transmit equipment integrity
    - Maximum ASA transmit subsystem continuity of service
    - Maximum state data latency
    - Maximum time error of state data
    - Minimum NACp, NACv, NIC, SIL
    - Maximum time to indicate integrity change
    - Minimum transmitted information requirements

ASA Capability Level (ACL)

- **ACL conveys the applications "available", but not necessarily in current use on the transmitting aircraft**
  - **"Available" indicates that the system is currently capable of performing the intended function**
  - **Similar to TQL, ACL provides limited groupings**
    - Also provides other users, including ground systems, with information necessary to allow use of some applications, to request use of applications, and to support use of some applications
    - Provides the flight crew with information about the application capabilities of ownship
  - **ACLs are also hierarchical, i.e., higher ACLs announce that a participant supports the capabilities of all lower ACLs**

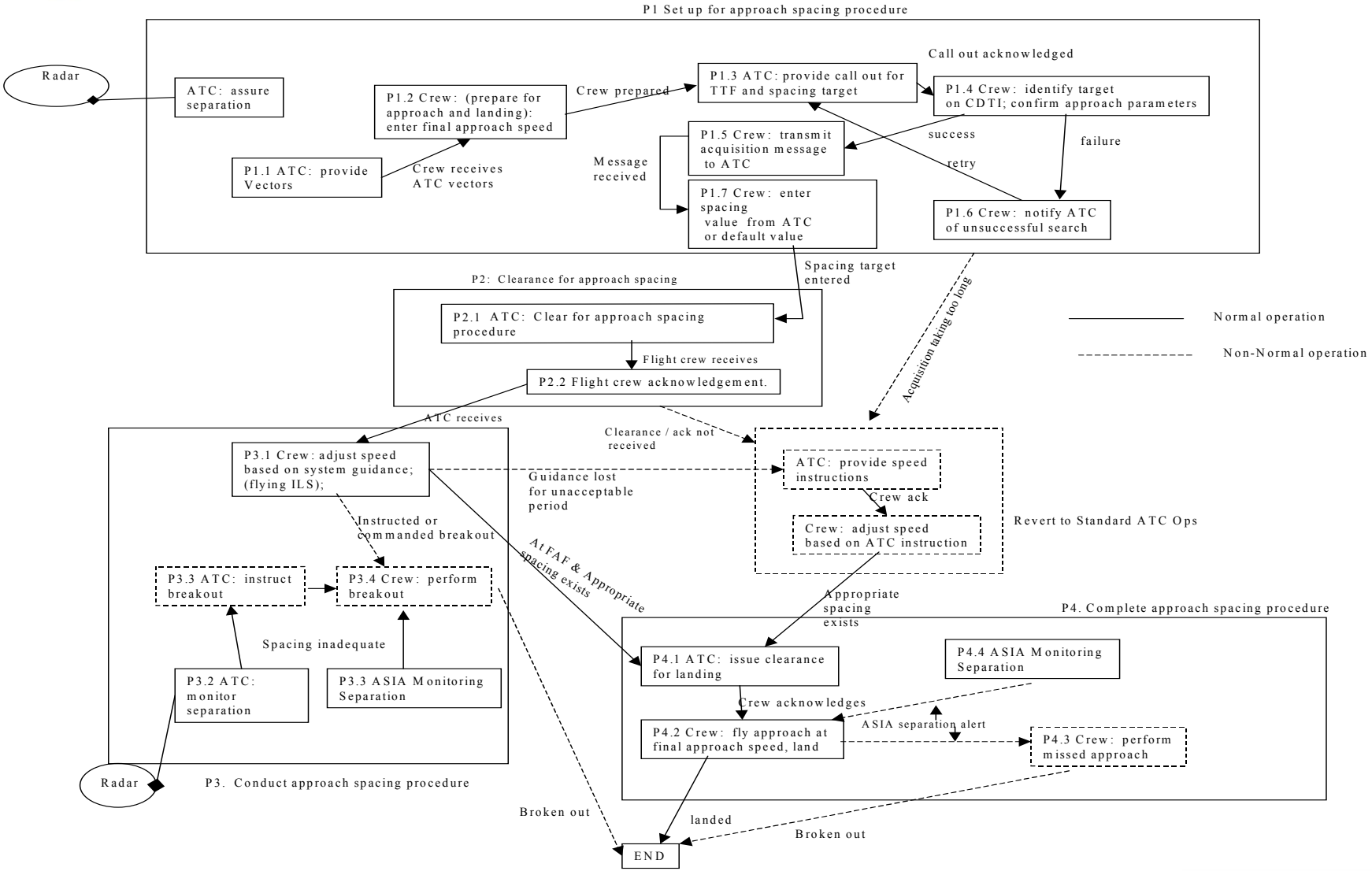
ACL Categories

- **'Transmit-only' ACL**
  - **Indicates aircraft transmits ADS-B messages, but has no on-board applications capabilities available**
- **'Basic' ACL**
  - **For 'basic' applications, other users have no operational need to know that the applications are available and operational on the broadcasting aircraft**
    - An example is Enhanced Visual Acquisition (EVAcq)
    - Optionally, combinations of ASSA, FAROA, and CD are included
- **'Intermediate' ACL**
  - **These applications involve cooperation with ATC and thus are elevated to 'intermediate' ACL status**
    - Example is Enhanced Visual Approach (EVApp)
- **'Advanced' ACLs (future)**
  - **'Advanced' applications are envisioned to provide a means to shift responsibility from ATC to the flight deck in certain airspace or for certain operational procedures**
    - Advanced 1, e.g., Airborne Conflict Management (ACM) - requires maneuvering guidance and additional alerting capabilities
    - Advanced 2, e.g., ASIA and ICSPA - short range apps with higher criticality and more stringent requirements

ASA MASPS - Analysis Methodology Overview

- **Follows RTCA DO-264 / EUROCAE ED-78A process to the extent possible. Extensions needed for surveillance applications versus comm systems.**
- **OSED**
  - **Provides description of the operational service and environment definition, i.e., application description**
    - Includes modeling of applications using a phase / process diagrams that identify 'actions' by 'actors', i.e., ATC, flight crew, automation systems
- **OSA - Operational Safety Assessment**
  - **OHA - Operational Hazard Assessment**
    - Evaluates each 'action' for operational hazards
      - Identifies potential effect(s) of detected failure(s)
      - Examines potential operational consequence(s) of undetected misleading information
    - Results are captured in a Safety Table
  - **Fault tree analysis**
    - Evaluates system integrity requirements for an operational consequence
    - Identifies operational hazards, avoidances and mitigations
- **OPA - Operational Performance Assessment**
  - **Nominal system performance via analysis**
    - E.g., static analyses, Monte Carlo simulations, etc.

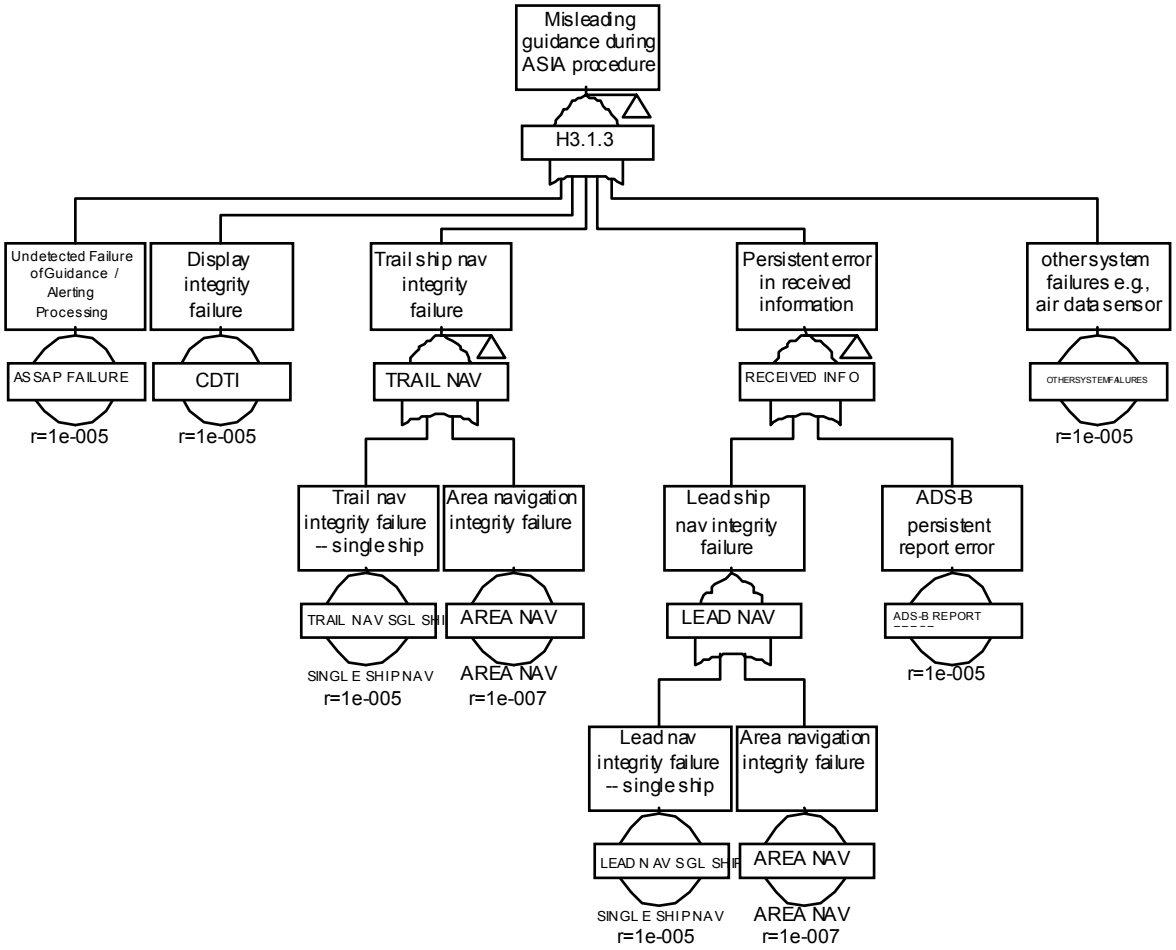
Phase and Process Diagram for ASIA



Safety Table (example entry for ASIA) Hazard for Process 3.1

Phase	Process	Hazard ID	Operational Hazard Description
P3: Conduct Procedure	P3.1 Crew: adjust speed based on system commands	H3.1.1	Erroneous speed maintained by flight crew
		H3.1.2	Loss of guidance during ASIA procedure
		H3.1.3	Erroneous guidance during ASIA procedure

Fault Tree Example for ASIA (Misleading Guidance Ops Hazard)



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Summary / Conclusions

- **ASA MASPS (RTCA DO-289) is a cornerstone standards document from RTCA for the development of future Aircraft Surveillance Applications**
  - **Provides detailed system and sub-system requirements for initial 5 applications (EVAcq, EVApp, ASSA, FAROA, CD)**
  - **Examines potential future 'stressing' requirements**
    - Probing analyses for ASIA, ICSPA, ACM
  - **Requirements grouped by Transmit Quality Level, ASA Capability Level**
  - **Requirements flow down to ADS-B & TIS-B MASPS, Link MOPS (UAT, 1090 MHz), and Airborne Separation Assistance System (ASAS) MOPS (currently under development)**
- **FAA/EUROCONTROL Requirements Focus Group (RFG) is now addressing harmonization of future applications and associated standards / methodologies**